



# Bulb yield stability study of onion lines over locations and years in Ghana and Mali

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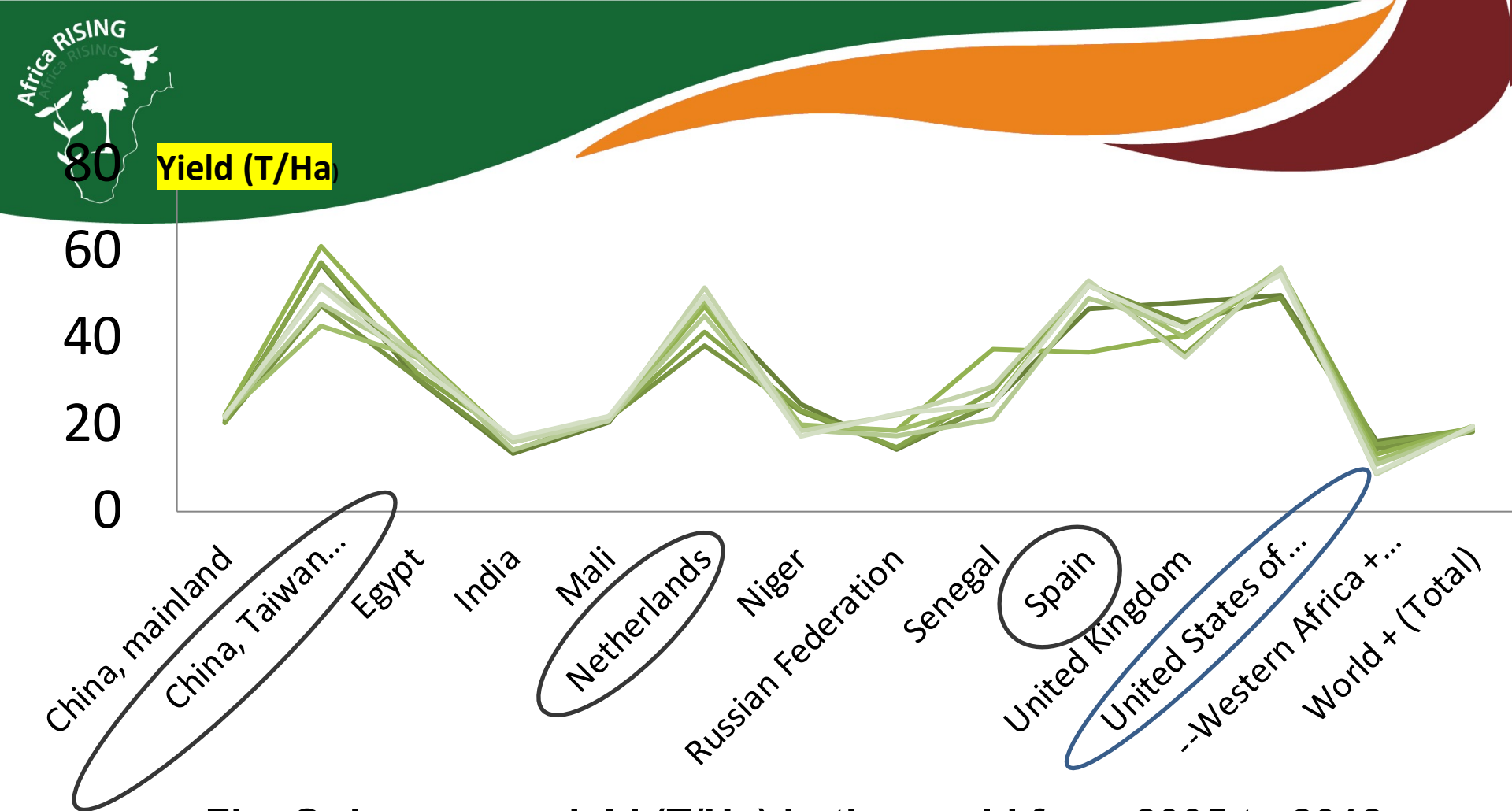
# Plan

- Background
- Objective
- Materials & method
- Results & discussion
- Conclusion



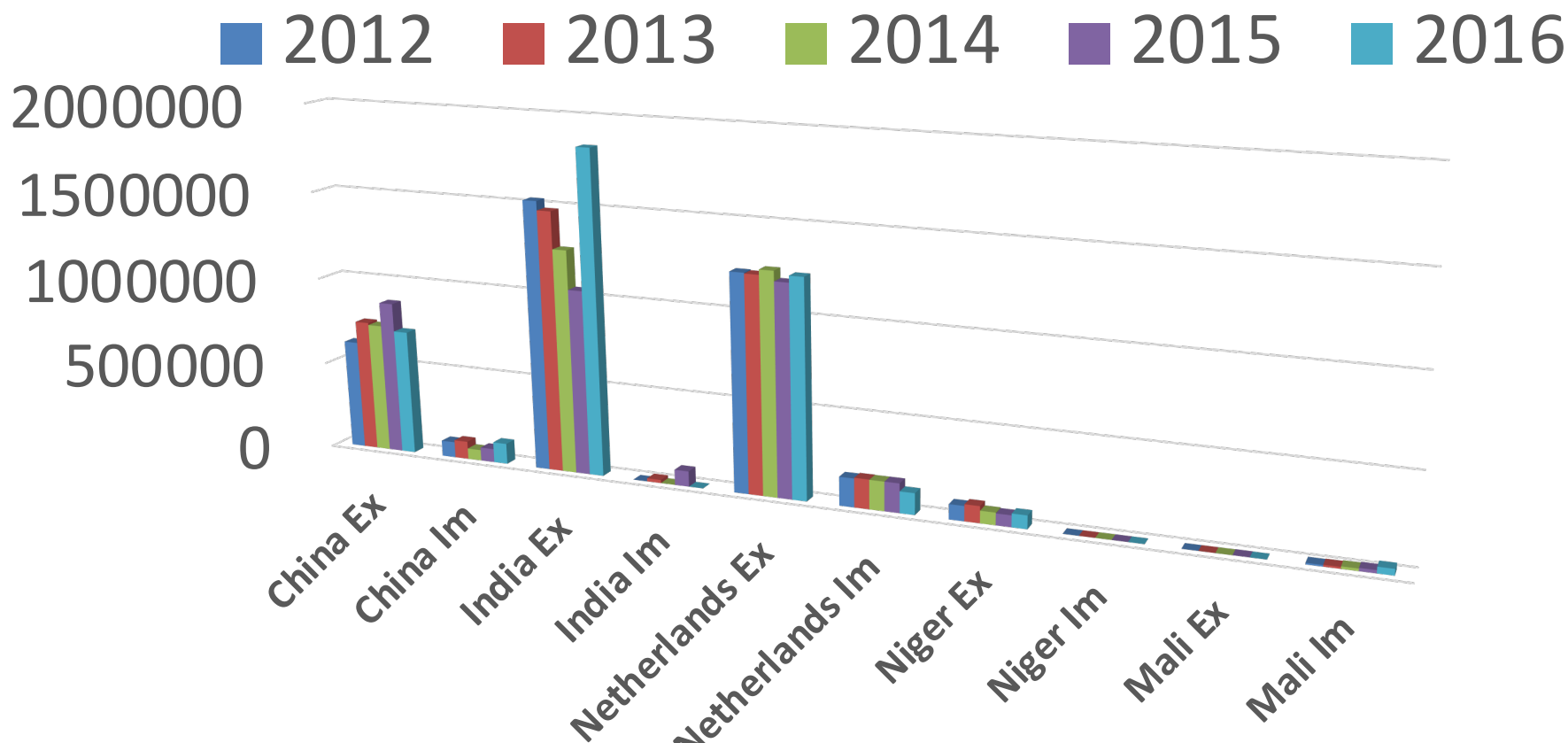
# I. Background

- ❑ Onion plays a key role as source of nutrients and income for people in sub-Saharan Africa
- ❑ However, few high-yielding varieties are available to farmers
- ❑ World top producers are China, India, USA, Iran & Russia
- ❑ World top exporters are Netherland, India, Mexico, Cont China, Egypt, USA, Spain
- ❑ World top importers are USA, Germany, United Kingdom, Russia, Malaysia, Japan, etc.
- ❑ Production, growing areas and yields vary according to countries & how intensive the production system is.



**Fig. Onion mean yield (T/Ha) in the world from 2005 to 2012**  
(FAOSTAT, 2015)





Imported (Im) & exported onion (Ex) in different countries (MT) from 2012 to 2016 (FAOSTAT, 2019)



# Key challenges

Constraints	Causes
Abiotic	<ul style="list-style-type: none"><li>✓drought in humid season</li><li>✓high moisture in humid season: mostly exotics</li></ul>
Post harvest	<ul style="list-style-type: none"><li>✓onion is perishable during storage</li></ul>
Genetic	<ul style="list-style-type: none"><li>✓Low diversity</li><li>✓Low adaptation</li></ul>
Technology transfer	<ul style="list-style-type: none"><li>✓weak national extension system</li><li>✓no perennial water sources, animal stray</li></ul>
Capacity	<ul style="list-style-type: none"><li>✓insufficient trained farmers, seed enterprises, technicians &amp; students</li></ul>



# Objective

**To identify adapted onion genotypes for a sustainable production in the Africa RISING project intervention zones of Northern Ghana and South Mali**



## II- Materials and Method

- Sets of 8 onion lines from the WorldVeg onion collection & 1 commercial check were evaluated during the cool and dry seasons from September to March for three years from 2018, 2019 and 2020
- The trials (>3 replicates) were carried out in technology parks & on farm fields under the joint management by farmers and researchers.
- The trial sites were Upper East and Northern Regions of Ghana and Sudan savanna zones of Mali (Bougouni and Koutiala)
- Plot dimensions were 2m x 2m, with planting densities of 20cm & 15cm between and within rows, respectively.





## II- Materials and Method (Contd.)

- ❑ Onion bulb weight was recorded for each plot after harvest
- ❑ Separate analysis of variances were performed for each location and season in a complete randomized design
- ❑ Combined Analysis of variance (Sites x year x genotypes) was made to determine the most stable varieties using the following stability Analysis models:
  - ❑ AMMI biplot,
  - ❑ GGE biplot,
  - ❑ Line-superiority measure (Lin and Binns, 1988), and
  - ❑ Ecovalence stability coefficients (Wricke, 1962)



## III Results & Discussion

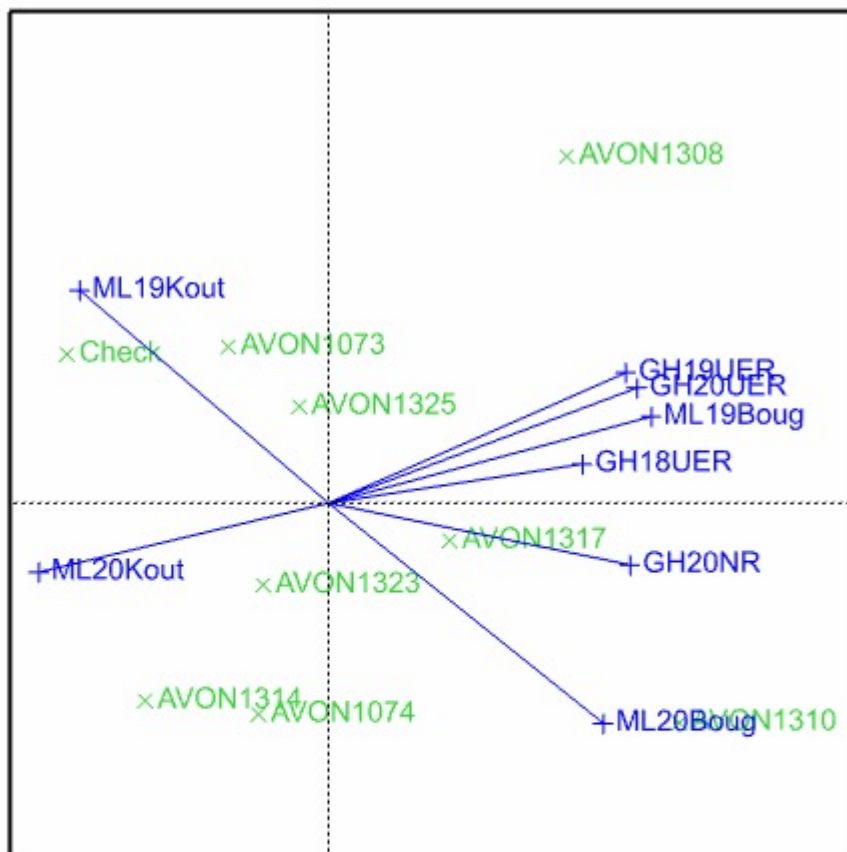
## **G x E interaction (AMMI) for yield performance (t ha<sup>-1</sup>) of onion varieties over years and locations in Ghana and Mali – 2018-2020**

Genotypes	GHANA				MALI					
	UER			NR	KOUTIALA		BOUGOUNI			
	2018	2019	2020	2020	2019	2020	2019	2020	Mean	Rank
AVON1308	33.16	33.30	36.73	33.88	29.00	27.81	26.47	10.35	28.81	3
AVON1310	32.38	32.45	33.64	34.81	-	-	-	-	33.32	1
AVON1325	28.04	-	-	-	-	35.31	-	-	31.68	2
AVON1314	27.69	20.09	25.08	30.75	28.50	-	20.73	-	25.47	5
AVON1074	26.65	24.52	27.56	31.56	25.67	35.00	20.93	11.93	25.48	4
AVON1073	25.26	30.03	28.34	28.12	27.17	28.75	21.00	5.62	24.29	7
AVON1323	-	23.15	23.31	27.88	26.33	31.56	23.13	10.50	23.68	8
AVON1317	-	-	-	-	-	27.19	-	12.13	19.66	9
Check	28.04	26.49	23.36	26.50	-	-	-	-	25.02	6
Mean	28.75	26.49	28.29	30.50	27.33	30.94	22.45	10.10	25.61	
SE	1.47	0.83	0.69	0.91	0.87	1.20	0.84	0.73	-	
Year x Loc x Var. p-value (5%)	<0.001 **									

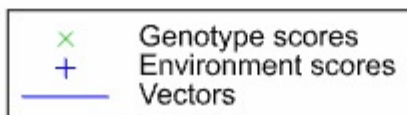
UER: Upper East Region, NR: Northern Region; SE: Standard error

## a-AMMI bi-plot analysis for onion yield

PC2 - 14.02%



PC1 - 65.78%

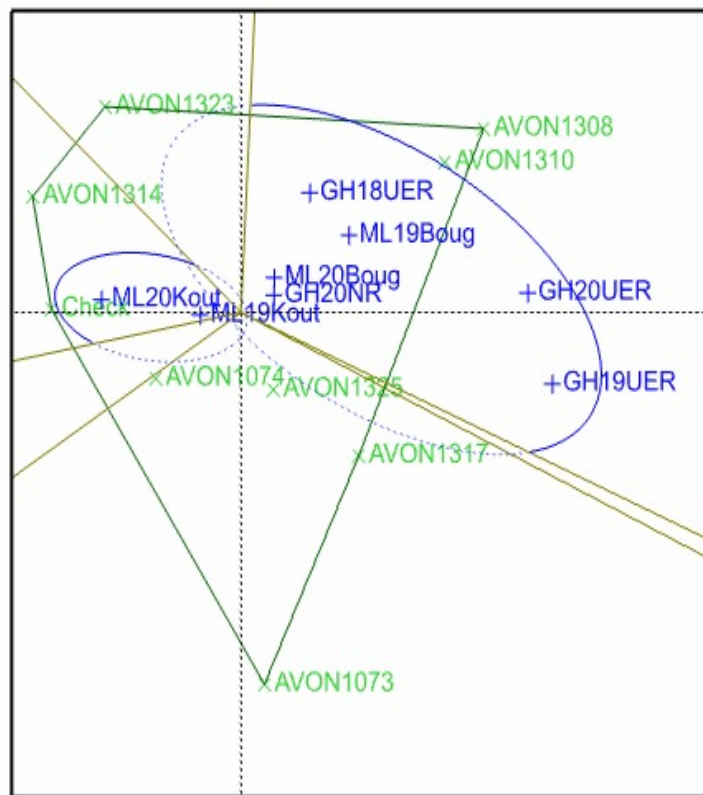


- Most stable lines are AVON1325, AVON1323 and AVON1317
- Only AVON1325 (31.68Kg/ha) has above average yield (25.61 T/Ha)

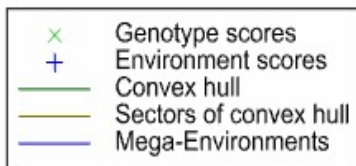
# b-GGE: Genotype + GxE interaction (GGE) bi-plot

GGE biplot for CB\_Yield\_T\_Ha (environment scaling)

PC2 - 8.08%



PC1 - 82.34%



- 2 mega-environments discovered:
  - Mega-E1 with 2 environments in Koutiala  
AS OPPOSED to
  - Mega E2 with 6 environments from Ghana and Bougouni in Mali.
- Genotype AVON1308 is highest yielding** and was the best performing variety across locations & years in the mega-environment 1 (Ghana and Bougouni). AVON 1310 is stable.
- AVON 1314 was the winning variety** in the Mega-environment 2 formed by Koutiala (over 2 years).

ML: **Mali**

GH: **Ghana**

**Years:**

Kout: Koutiala

UER: Upper East Region

18: 2018

Boug: Bougouni

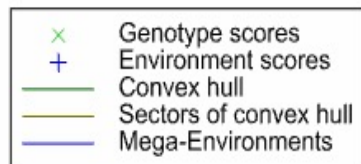
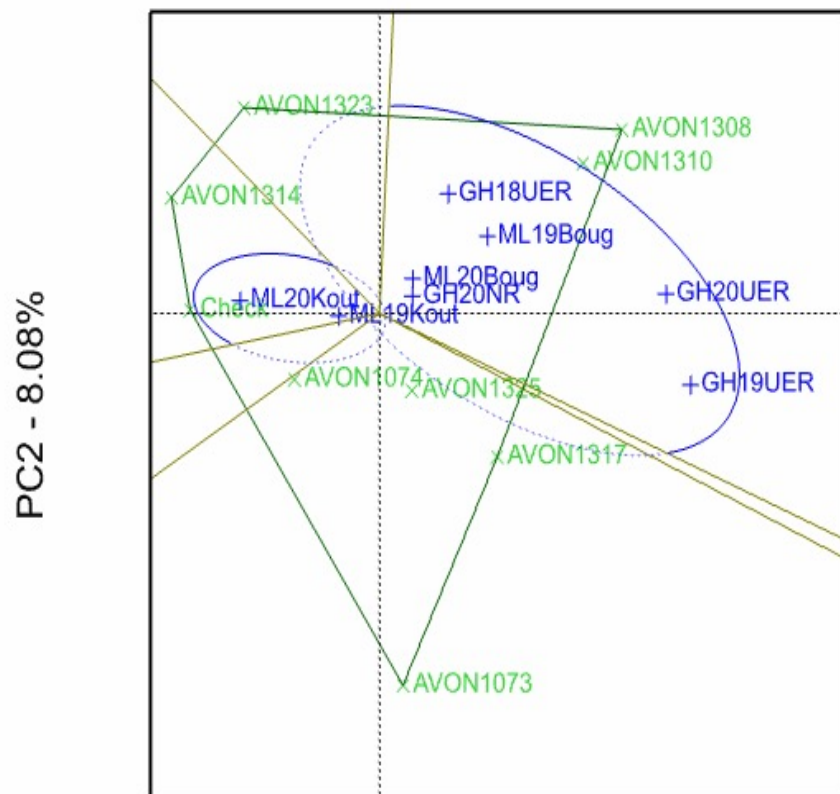
NR: Northern Region

19: 2019

20: 2020



# b-GGE: Genotype + Genotype interaction (GGE) bi-plot



- AVON1323, AVON1073 (in the vertex), AVON1317 AVON1074 and AVON1325 do not belong to any mega-environment: they are unfavorable for the group of tested environments ; have low productivity and not suitable for recommendation..

ML: **Mali**

Kout: Koutiala

Boug: Bougouni

GH: **Ghana**

UER: Upper East Region

NR: Northern Region

**Years:**

18: 2018

19: 2019

20: 2020



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# Wricke's ecovalence stability Coefficients: $Wi$

Genotype	$Wi$	Bulb yield (T/Ha)
AVON1310	2.20	33.32
AVON1325	11.60	31.68
Check	13.99	25.02
AVON1317	14.45	19.66
AVON1323	29.46	23.68
AVON1314	36.01	25.47
AVON1074	36.90	25.48
AVON1073	41.28	24.29
AVON1308	91.94	28.81
Mean		25.61

- ❑ 4 genotypes AVON1310, AVON1325, Check variety and AVON1317 with smallest  $Wi$  values were more stable
- ❑ 2 genotypes AVON1310 and AVON1325 were better because they were above average yield (25.61T/Ha) are



# d-Lin and Binns Superiority measure of genotype performance (Pi)

Genotype	Stability superiority coefficient (Pi)	Bulb yield (T/Ha)
AVON1310	1.32	33.32
AVON1308	3.77	28.81
AVON1325	6.56	31.68
AVON1074	15.78	25.48
AVON1317	16.50	19.66
AVON1073	19.09	24.29
AVON1323	25.99	23.68
AVON1314	32.03	25.47
Check	49.1	25.02
Mean		25.61

□ According to Lins & Binns (1988) genotypes AVON1310, AVON1308 and AVON1325 with the smallest Pi value are the most stable

□ These genotypes also gave bulb yield higher than the grand mean



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# Summary of stable genotypes from stability analysis models

Mega-E	AMMI biplot	G-GGE biplot	Wricke's ecovalence (Wi)	Lin and Binns Superiority measure of performance (Pi)	Frequency
(2) Koutia la	AVON1317				1
			AVON1325	AVON1325	2
		AVON1308		AVON1308	2
(1) Ghana + Bougouni		AVON1308			1
		AVON1310	AVON1310	AVON1310	3
	AVON1325				1
	AVON1323				1
			Check		1

## Conclusion & recommendations

- In Mega-environment 1 (*Ghana NR, UER & Mali, Bougouni*), **AVON1308** (28.81T/Ha) & **AVON1310** (33.32T/Ha) were most stable genotypes
- In Mega-environment 2 (*Koutiala 2019 & 2020*) **AVON1308 & AVON1325** are most stable genotypes with above average yield (25.61T/Ha)
- Across all environments (*Ghana and Mali*), **AVON1308** was the most stable genotype
- These genotypes with above average yield (>25,61 T/Ha) also out-yielded currently released lines (AVON1074 & AVON1073) and can be recommended for sustainable production



**AVON1308**



**AVON1310**



**AVON1323**





Thank you

